REMARKS

This paper is responsive to the Office Action mailed from the Patent and Trademark Office on April 1, 2003, which has a shortened statutory period set to expire July 1, 2003.

Claims

Claims 1-10 and 21-30 are pending in the above-identified application. Claim 27 is rejected under 35 USC 112, and Claims 1-10 21, and 24-30 are rejected under 35 USC 103 as being unpatentable over cited references that are identified below. Claims 22 and 23 are withdrawn from consideration by the Examiner.

In the current paper, Claim 27 is amended in response to the rejection under 35 USC 112. All other claims remain as originally filed or as amended in the paper mailed to the USPTO on Feb. 3, 2003. No new matter is entered. Reconsideration and withdrawal of the pending rejections in view of the following remarks is respectfully requested.

Rejection Under 35 USC 112, Amendment to Claim 27

Claim 27 is amended to delete "formed from the first metal layer" in response to the rejection raised under 35 USC 112, second paragraph. No new matter is entered by this amendment.

Rejection Under 35 USC 103

Claims 1-3 and 6

Claims 1-3 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kingsley et al, (USPAT 5587591; herein "Kingsley") in view of Ahn (USPAT 6037248). In summary, the Examiner argues that "It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the air gap of Ahn in the device of Kingsley in order to

reduce the capacitance between the lines as taught by Ahn in column 3, lines 23-26."

The present rejection is traversed because one skilled in the art of image sensors would understand that the air gap arrangement disclosed by Ahn is inconsistent with the photosensor structure taught by Kingsley. In particular, those skilled in the art of amorphous silicon (a-Si) based photosensor arrays would understand that Ahn's MOSFET-based integrated circuit wiring method would both (a) damage Kingsley's thin-film transistor (TFT), and (b) fail to provide proper support the a-Si photosensor material formed over the TFTs. These arguments are developed in detail in the following paragraphs.

Kingsley teaches a low noise fluoroscopic radiation imager in which a TFT 134 is provided to access a photosensor 120. Kingsley teaches that photosensors 120 are arranged with a pitch of 35 to 500 microns, and indicates that the wiring (e.g., scan lines 131 and data lines 132) are located along the periphery of each photosensor "pixel":

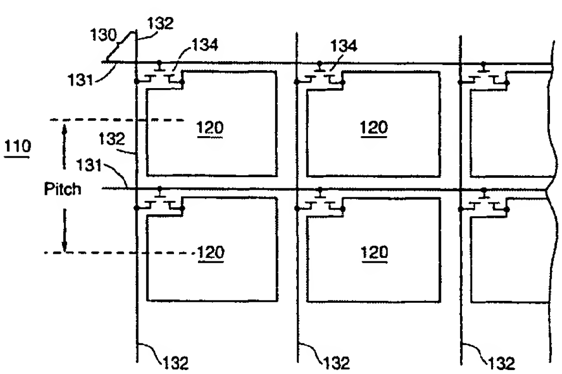

FIG. 1 (B)

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The pitch of imager **100** is determined by the distance between the centers of pixels along a selected axis of the array (e.g., the axis of the data lines **132** as shown in FIG. 1(B)). Low noise solid state radiation imagers in accordance with this invention typically have a pitch in the

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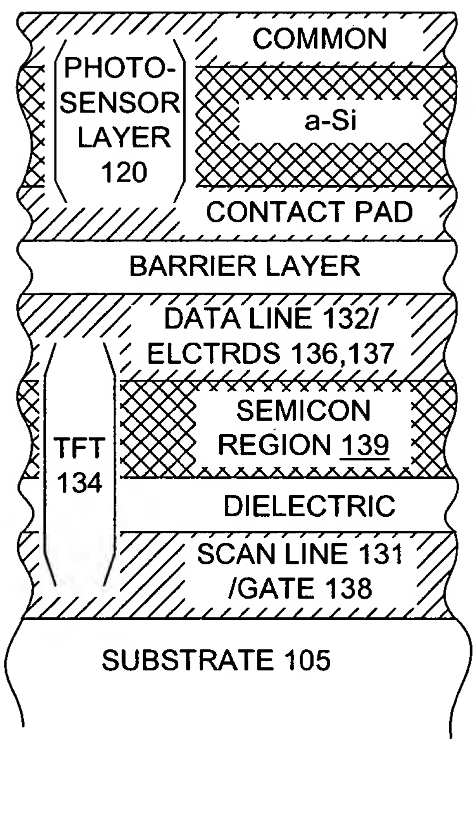
range between about 35 and 500 microns. Imagers having larger areas of switched silicon exhibit higher noise than imagers having smaller areas of switched silicon; higher noise in the imager requires the use of larger x-ray exposures to obtain the same resolution image.

Further, as set forth in the text provided in Kingsley's column 4, line 57 to column 5, line 21 (reproduced below along with a representative cross-section generated by Applicant for reference), Kingsley teaches that the TFT structure is formed under photosensor 120. In particular, Kingsley teaches forming an array of TFTs by forming scan lines 131 and associated gate

electrodes 138 on a substrate 105 using a first metal layer, then forming semiconductor gate structures 139 (amorphous silicon) along with a suitable dielectric layer over corresponding scan lines/gate structures, and then forming data lines 132 and corresponding source electrodes 137 using a second metal layer. As highlighted in the text below, Kingsley points out on line 10 of column 5 that a portion of the dielectric layer is located between the scan and data lines at the "crossovers". Kingsley then teaches forming a dielectric barrier layer over the TFT structures, and then forming photosensors 120 on top of the dielectric layer:



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A representative portion of an imager array **130** comprising a low noise addressable TFT array in accordance with this invention is illustrated in the modified plan view of FIG. 2(A). Components in multiple layers (that is, some components illustrated overlie other components illustrated in this Figure) make up the low noise TFT array. Scan line **131** is typically disposed on substrate **105**; and extension from scan line **131** comprises gate electrode **138** of TFT **134**. A semiconductive region **139** is disposed over gate electrode **134** (with a dielectric layer (not shown), such as silicon nitride or silicon dioxide disposed therebetween). Semicon-

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ductive region typically comprises a layer of amorphous silicon (a-Si) and an overlying layer of doped a-Si (such as a-Si doped to exhibit n type conductivity),

Next, the conductive material comprising data lines **132**, source electrode **137**, and drain electrode **136** are disposed to overly semiconductive region **139**. The conductive material typically comprises chromium, aluminum, molybdenum, tungsten, titanium, and the like. Data line **132** similarly overlies scan line **131** at crossover region **140**, with at least a dielectric material disposed therebetween (typically the same dielectric material disposed between gate electrode **138** and semiconductive region **139**. A barrier layer (not shown) of dielectric material (such as inorganic dielectric material (silicon nitride or the like) and/or organic dielectric material (such as polyimide) is typically disposed over TFT **134** prior to the formation of photosensor **120**; photosensor **120** comprises a bottom electrical contact pad (shown in outline in FIG. 2(A) but not to scale) electrically coupled to source electrode **137**, an overlying photodiode body (not shown) comprising semiconductive layers (e.g., a-Si and doped silicon layers) and a common electrode (not shown) disposed over the top of the photodiode body.

In contrast to Kingsley, Ahn discloses method of fabricating integrated circuit wiring with low RC time delay with reference to the fabrication of a standard MOSFET-type integrated circuit structure. Those of ordinary skill in the art will recognize the MOSFET-type structure disclosed in Ahn's Fig. 2 and associated description (reproduced below for reference) includes a polysilicon gate structure 36 formed on a gate oxide 33, and diffusion areas 38 formed on either side of the gate structure.

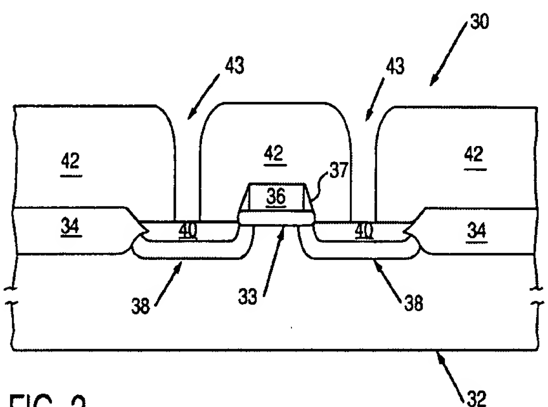

FIG. 2

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FIG. **2** shows a cross-section of a substrate assembly **30** at an early stage in the fabrication process of the present invention. The substrate assembly **30** includes a substrate layer **32**, which is the lowest layer of semiconductor material on a wafer, and additional layers or structures formed thereon. A LOCOS process is performed to provide a layer of gate oxide **33** separated by field oxide regions **34**. A polysilicon layer **36** is deposited and etched to provide a contact area, typically for the gate terminal of a transistor. A spacer **37** may be formed along the layer **36** using conventional techniques. Impurities are diffused into the substrate **34** through suitable masks to form diffusion areas **38**. The diffusion areas **38** give rise to depletion regions that essentially isolate the source and drain terminals of the transistor from one another by two diodes. Silicide layers **40** are formed on the diffusion areas **38**. The silicide layers **40** are formed by depositing a refractory metal such as titanium, platinum, palladium, cobalt, or tungsten on polysilicon. The metal/silicon alloy is then sintered to form the silicide layers **40**.

Above the basic MOSFET-type structure introduced in Ahn's Fig. 2, Ahn discloses forming alternate layers of photoresist and metal, and then removing the photoresist by ashing to complete the integrated circuit structure:

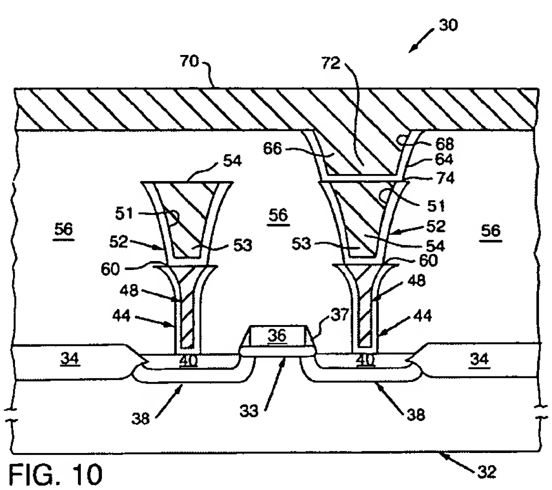

FIG. 10

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FIG. **10** shows a resulting substrate assembly **30** of FIG. **9** with the first metal layer **54** and the second metal layer **70** formed. The photoresist layers **42**, **50** and **62** are removed by, for example, ashing in oxygen plasma to form air gaps **56**. The metal layers **54** and **70** are supported by columns **60** and **74** formed by the combination of the metal plugs **48** and **66** and the contacts **53** and **72**. The air gaps **56** have a dielectric constant of 1, thereby reducing the capacitance of the resulting structure. By selecting appropriate metal conductors which have a low resistance, the RC time constant of the resulting structure is reduced.

Applicants contend that it would not have been obvious to utilize the teachings of Ahn in the fabrication of the fluoroscopic radiation imager of Kingsley for at least the following practical reasons.

First, utilizing the teachings of Ahn would require replacing Kingsley's dielectric layer with photoresist. That is, in order to form the "air gap crossover" taught by Ahn, the dielectric layer located between scan lines 131 and data lines 132 at the "crossovers" would be replaced with photoresist. However, as set forth above, Kingsley teaches that this dielectric is also located between gate structures 139 and corresponding scan lines 131/gate structures 138. Accordingly, removing the photoresist from between scan lines 131 and data lines 132, as taught by Ahn, would also damage the TFT structure by undercutting semiconductor region 139, possibly causing contact between semiconductor 139 and scan line 131. Accordingly, it would not have been obvious to modify Kingsley using the method taught by Ahn because the resulting structure could be inoperable.

Second, the structure taught by Ahn would fail to provide proper support for the photosensor structure utilized in Kingsley. As set forth above, the data wires utilized by Kingsley are spaced at a pitch of 35 to 500 microns. Removing dielectric/photoresist from between these widely spaced wires would produce voids (holes) that would greatly complicate the subsequent formation of the overlying photosensor. Accordingly, for this additional reason, it would not have been obvious to modify Kingsley using the method taught by Ahn because the resulting structure would be substantially more difficult to produce.

For at least the above reasons Applicants respectfully request reconsideration and withdrawal of the stated rejection of Claim 1.

Claims 2, 3 and 6 are dependent from Claim 1, and are therefore distinguished over the cited prior art for at least the same reasons as those set forth with respect to Claim 1.

Claim 4

Claim 4 is rejected under 35 USC 103 as being unpatentable over Kingsley in view of Ahn, and further in view of Akiyama (USP 5,712,494, herein "Akiyama").

Claim 4 is dependent from Claim 1, and is therefore distinguished over Kingsley and Ahn for at least the same reasons as those set forth above with respect to Claim 1. Further, Akiyama fails to overcome the deficiencies of Kingsley and Ahn. Therefore, Claim 4 is distinguished over the cited prior art for reasons similar to those set forth above with respect to Claim 1.

Claim 5

Claim 5 is rejected under 35 USC 103 as being unpatentable over Kingsley in view of Ahn, and further in view of Hwang (USP 6,337,284, herein "Hwang").

Claim 5 is dependent from Claim 1, and is therefore distinguished over Kingsley and Ahn for at least the same reasons as those set forth above with respect to Claim 1. Further, Hwang fails to overcome the deficiencies of Kingsley and Ahn. Therefore, Claim 5 is distinguished over the cited prior art for reasons similar to those set forth above with respect to Claim 1.

Claim 7

Claim 7 is rejected under 35 USC 103 as being unpatentable over Kingsley in view of Ahn, and further in view of Street (USP 5,789,737, herein "Street").

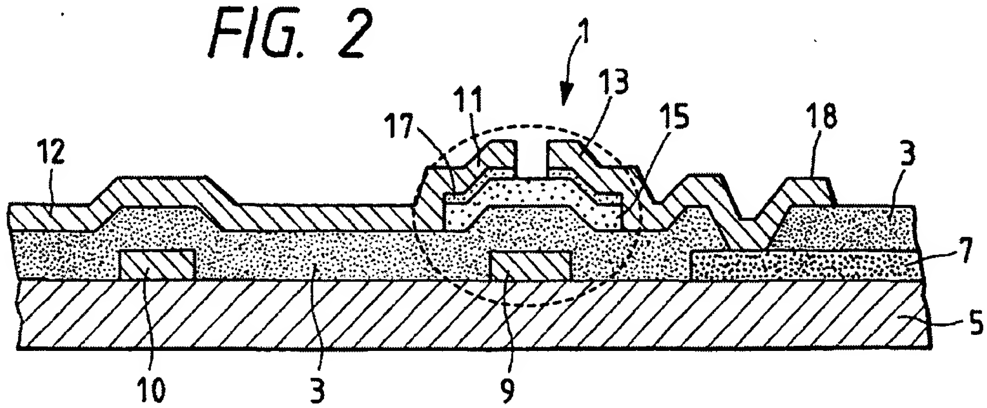
Claim 7 is dependent from Claim 1, and is therefore distinguished over Kingsley and Ahn for at least the same reasons as those set forth above with respect to Claim 1. Further, Street fails to overcome the deficiencies of Kingsley and Ahn. Therefore, Claim 7 is distinguished over the cited prior art for reasons similar to those set forth above with respect to Claim 1.

Claim 8 and 27-30

Claims 8 and 27-30 are rejected under 35 USC 103 as being unpatentable over Fukuda in view of Ahn. Similar to the rejection of Claim 1, in rejecting Claims 8 and 27-30, the Examiner relies on Ahn's method for generating an "air-gap".

Independent Claims 8 and 27-30 are believed to be distinguished over Fukuda and Ahn for reasons similar to those provided above with reference to Claim 1. In particular, Applicants believe it would not have been obvious to utilize the methods disclosed by Ahn with the electronic element and method of Fukuda because, as is evident in Fukuda's Fig. 2 (reproduced below for reference), eliminating Fukuda's insulating layer 3 would cause amorphous silicon gate structure 15 to collapse onto gate electrode 9, thus shorting out the TFT:

FIG. 2



For at least the above reason, it would not have been obvious to combine the teachings of Fukuda and Ahn to produce the structure recited in independent Claims 8 and 27-30.

Claim 9

Claim 9 is rejected under 35 USC 103 as being unpatentable over Fukuda in view of Ahn, and further in view of Antonuk (USP 5,262,649, herein "Antonuk").

Claim 9 is dependent from Claim 8, and is therefore distinguished over Fukuda and Ahn for at least the same reasons as those set forth above with respect to Claim 8. Further, Antonuk fails to overcome the deficiencies of Fukuda and Ahn. Therefore, Claim 9 is distinguished over the cited prior art for reasons similar to those set forth above with respect to Claim 8.

Claim 10

Claim 10 is rejected under 35 USC 103 as being unpatentable over Fukuda in view of Ahn, and further in view of Kunikiyo (USPAT 2002/0135041, herein "Kunikiyo").

Claim 10 is dependent from Claim 8, and is therefore distinguished over Fukuda and Ahn for at least the same reasons as those set forth above with respect to Claim 8. Further, Kunikiyo fails to overcome the deficiencies of Fukuda and Ahn. Therefore, Claim 10 is distinguished over the cited prior art for reasons similar to those set forth above with respect to Claim 8.

Claim 21

Claim 21 is rejected under 35 USC 103 as being unpatentable over Fukuda in view of Ahn, and further in view of Akiyama.

Claim 21 is dependent from Claim 8, and is therefore distinguished over Fukuda and Ahn for at least the same reasons

as those set forth above with respect to Claim 8. Further, Akiyama fails to overcome the deficiencies of Fukuda and Ahn. Therefore, Claim 21 is distinguished over the cited prior art for reasons similar to those set forth above with respect to Claim 8.

Claim 24

Claim 24 is rejected under 35 USC 103 as being unpatentable over Fukuda in view of Ahn, and further in view of Hwang.

Claim 24 is dependent from Claim 8, and is therefore distinguished over Fukuda and Ahn for at least the same reasons as those set forth above with respect to Claim 8. Further, Hwang fails to overcome the deficiencies of Fukuda and Ahn. Therefore, Claim 24 is distinguished over the cited prior art for reasons similar to those set forth above with respect to Claim 8.

Claim 25

Claim 25 is rejected under 35 USC 103 as being unpatentable over Fukuda in view of Ahn and Hwang, and further in view of Pedder (USP 5,604,658).

Claim 25 is dependent from Claim 24, and is therefore distinguished over Fukuda, Ahn and Hwang for at least the same reasons as those set forth above with respect to Claim 24. Further, Pedder fails to overcome the deficiencies of Fukuda, Ahn and Hwang. Therefore, Claim 25 is distinguished over the cited prior art for reasons similar to those set forth above with respect to Claim 24.

Claim 26

Claim 26 is rejected under 35 USC 103 as being unpatentable over Fukuda in view of Ahn and Hwang, and further in view of Kingsley.

Claim 26 is dependent from Claim 24, and is therefore distinguished over Fukuda, Ahn and Hwang for at least the same reasons as those set forth above with respect to Claim 24. Further, Kingsley fails to overcome the deficiencies of Fukuda, Ahn and Hwang. Therefore, Claim 26 is distinguished over the cited prior art for reasons similar to those set forth above with respect to Claim 24.

For the above reason, Applicant respectfully requests reconsideration and withdrawal of the rejections under 35 USC 103.

<u>Claims 22 and 23</u>

Claims 22 and 23 were withdrawn from consideration as being directed to a non-elected invention. Should the Examiner withdraw the rejections to Claims 8 and 21 (from which Claims 22 and 23 depend), Applicant respectfully requests that these claims be reinstated.

CONCLUSION

Claims 1-10 and 21-30 are pending in the present Application. Reconsideration and allowance of these claims is respectfully requested. If there are any questions, please telephone the undersigned at (408) 451-5902 to expedite prosecution of this case.

Respectfully submitted,

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I hereby certify that this correspondence is being deposited with the United States Postal Service as FIRST CLASS MAIL in an envelope addressed to: Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on June 18, 2003.

6/18/03 Rebecca A. Baumann

Date Signature